State Board of Education Approved
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COMPUTER-AIDED DESIGN (CAD)

COURSE DESCRIPTION

Computer-Aided Design* **is a course in which students will learn to use a CAD program to create engineering drawings including plan drawings, assembly drawings, welding and process drawings, cross sections, 3D representations, and bills of materials. The course consists primarily of individual drawing projects, with some group projects. Emphasis is on drawing projects of increasing complexity.**

Prerequisite(s):	**Engineering Design/CAD; Algebra I or Math for Technology II**
	Geometry (may be concurrent)
Recommended Credits:	**2**
Recommended Grade Level(s):	**11th or 12th**

***This course may be offered as a part of the Construction or the Manufacturing Sub-Cluster, depending upon the student's career focus. This course has the same prerequisites in both sub-clusters.**

STANDARDS

1.0 Students will create and print two- and three-dimensional scale drawings and orthographic projections using a CAD program.

2.0 Students will apply dimensions and tolerances to components of a technical drawing to assure a working fit between components.

3.0 Students will extract information from a technical drawing to create a bill of materials.

4.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

STANDARD 1.0

Students will create and print two- and three-dimensional scale drawings and orthographic projections using a CAD program.

LEARNING EXPECTATIONS

The student will:

1.1 Create and print two-dimensional scale plan drawings.
1.2 Create and print orthographic projections of three-dimensional objects.
1.3 Create and print drawings of three-dimensional objects including parallel extrusion, perspective extrusion, and three-dimensional isometrics.
1.4 Create and print engineering drawings of complex objects requiring multiple sectional views.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

1.1.A Represents location and size of all entities in the drawing.
1.1.B Uses dimension information in the drawing.
1.1.C Uses symbol libraries in the drawing where available and appropriate.
1.1.D Demonstrates layer structure to maximize the drawing's utility.
1.2.A Represents orthographic views of solid objects.
1.2.B Uses dimension information in the drawing.
1.2.C Includes hidden lines to show features not visible in the view of a solid-object.
1.3.A Uses the appropriate extrusion technique for the three-dimensional object drawing's intended purpose.
1.3.B Portrays isometric entities with appropriate skew angles.
1.4.A Combines plane and three-dimensional representations along with appropriate cross-sectional drawings to represent interior detail.
1.4.B Uses dimension information in the drawing.
1.4.C Indicates location of cross sections.

SAMPLE PERFORMANCE TASKS

Students can complete the following drawing projects:

- Complete a plan drawing of the classroom or computer lab.
- Complete a solid-object drawing of the exterior details of a computer monitor.
- Create a three-dimensional drawing of a student or teacher desk.
- Create a three-dimensional drawing using extrusion of a spur gear.
- Complete a project to draw a snap ring, motor shaft and motor.
- Complete a project to draw an assembly and exploded view, e.g. a belt tightener.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995. International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Project Lead the Way curriculum. Mathematics content.

STANDARD 2.0

Students will apply dimensions and tolerances to components of a technical drawing to assure a working fit between components.

LEARNING EXPECTATIONS

The student will:

2.1 Determine the appropriate tolerances for each dimension in a drawing, including assembly, operational, and cost criteria for structures and mechanisms.
2.2 Include global tolerances in the drawing title block when appropriate.
2.3 Include explicit tolerances on a drawing's dimensions when appropriate.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

2.1.A Maintains a portfolio of notes, calculations, and reasoning to defend their choice of tolerances shown on drawings.
2.1.B Explains the intended assembly operations for structures and mechanisms.
2.1.C Explains the operation of mechanisms and the impact of tolerances on that operation.
2.1.D Explains the cost impact of their choice of tolerances.
2.2.A Identifies when the use of global tolerances is applicable and appropriate.
2.2.B Inserts a global tolerance in the title block of their drawing.
2.3.A Identifies when the use of explicit tolerances is applicable and appropriate.
2.3.B Inserts explicit tolerances on individual dimensions.

SAMPLE PERFORMANCE TASKS

Students can complete the following drawing projects:

- Complete a project to design a bookcase to given specifications, to be assembled by the end user.
- Complete a project to draw an assembly and exploded view, e.g. a belt tightener.
- Complete a project to design and draw a steel structure including bolted joints.
- Complete a project to design and draw a belt-drive with two stages of speed reduction, employing both pillow block and flange-mount bearings.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.
International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000.

Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Project Lead the Way curriculum. Mathematics content.

STANDARD 3.0

Students will extract information from a technical drawing to create a bill of materials.

LEARNING EXPECTATIONS

The student will:

3.1 Identify the available form(s) of each raw material required for the assembly and make defendable recommendations.
3.2 Make a list of each type of raw material with all required specifications for an assembly.
3.3 Make a list and specifications for finished-goods components required of an assembly.
3.4 Identify allowable alternates or substitutions (if any) on the bill of materials.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

3.1.A Maintains a portfolio of notes, calculations, and reasoning to describe the materials required for the assembly.
3.1.B Maintains a portfolio of notes, calculations, and reasoning to describe the recommended purchase form of materials for the assembly, considering criteria such as minimizing scrap, minimizing cost, delivery schedule, and preferred sources.
3.2.A Identifies each raw material needed for the assembly, along with pertinent specifications.
3.2.B Makes a list of raw material purchase items, including specifications, allowed vendors, and shipping restrictions.
3.3.A Identifies each finished-goods component needed for the assembly, along with pertinent specifications.
3.3.B Makes a list of finished-goods component items, including specifications, allowed vendors, and shipping restrictions.
3.4.A. Completes the bill of materials including approved alternate materials, components, and vendors.
3.4.B Includes the designated authority for approval of other changes to the bill of materials.

SAMPLE PERFORMANCE TASKS

Students can complete the following projects:

- For each drawing project previously assigned, complete a bill of materials.

INTEGRATION/LINKAGES

Foundation for Industrial Modernization (FIM). *What Manufacturing Workers Need to Know and Be Able to Do: National Voluntary Skill Standards for Advanced High Performance Manufacturing*. Washington, DC: National Coalition for Advanced Manufacturing, 1995.

International Technology Education Association. *Standards for Technological Literacy: Content for the Study of Technology.* International Technology Education Association. Reston, VA, 2000. Manufacturing Skill Standards Council. *A Blueprint for Workforce Excellence (draft skill standards for manufacturing.)* Manufacturing Skill Standards Council, 2001. Project Lead the Way curriculum. Mathematics content.

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STANDARD 4.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

4.1 Demonstrates dignity in work.
4.2 Participate in SkillsUSA-VICA as an integral part of classroom instruction.
4.3 Evaluate school, community, and workplace situations by applying problem-solving and decision-making skills.
4.4 Demonstrate the ability to work professionally with others.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

4.1 Demonstrates leadership skills through exhibiting characteristics of integrity and pride in work.
4.2.A Demonstrates employability skills.
4.3 Analyzes situations in the workplace and uses problem-solving techniques to create a desirable environment.
4.4.A Participates in job shadowing in an area of the manufacturing or drafting industry.
4.4.B Manages an officer or national voting delegate campaign with Tennessee SkillsUSA-VICA.

SAMPLE PERFORMANCE TASKS

- Prepare a resume.
- Participate in various SkillsUSA-VICA programs and/or competitive events.
- Attend a professional organization meeting such as, Chamber of Commerce meeting.
- Participate in the American Spirit Award competition with SkillsUSA-VICA.
- Develop a plan of action for an officer candidate or national voting delegate.
- Participate in job shadowing or internship within the drafting industry.

INTEGRATION LINKAGES

SkillsUSA-VICA, Professional Development Program, SkillsUSA-VICA, Communications and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Math, Math for Technology, Applied Communications, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on

Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

SAMPLING OF AVAILABLE RESOURCES

- *Applying AutoCAD®: A Step-by-Step Approach.* Glencoe, 2000.
- *Computer Numerical Controls for Machining.* McGraw-Hill, 1992.
- *CAD/CAM: Principles, Practice, and Manufacturing Management.* Prentice-Hall, 1998.
- *Brief Guide to AutoCAD® 2000.* Prentice-Hall, 2000.
- *AutoCAD® 2000: One Step at a Time Basics.* Prentice-Hall, 2000.